Space Weather Technical Forecast

Issued on Thursday, 05 September 2024 at 00:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares expected, slight chance of X-flares. Chance of S1/Minor Radiation Storms through the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate in the past 24hrs, with several M-class flares. The strongest was an M1.4 peaking at 04/0255 UTC from the unnumbered region next to AR3813 in the southeast quadrant. There are currently nine sunspot regions on the visible disc, 3 of which are unnumbered. AR3806 and AR3813 are the largest and most complex regions on the disc as AR3807 approaches the southwest limb, leading to an increasing reduction of confidence in its classification. AR3806 in the central disc has seen a proliferation of spots and appears to be increasing in complexity, with several mature penumbra forming and the presence of two delta configurations. AR3813 in the southeast has also seen a proliferation of spots and has been reclassified as Eai. The region is still showing significant looping in SDO imagery and is thought to be connected to the unnumbered region to the southeast of AR3813 contributing to the overall complexity observed on AIA-0171 and AIA-0094 imagery. The new region from the northeast limb has been numbered as AR3814. It is currently assessed as Hsx/Alpha but this may change as it rotates fully onto the disc. All the other regions are smaller and remain generally stable or unchanged.

No Earth-directed CMEs were observed in Coronagraph imagery in the last 24 hours. A very faint signal was observed lifting off the southwest limb at around 04/1600 UTC but preliminary analysis revealed that this is most likely far-sided and slow. No obvious source was identified.

Solar Wind / Geomagnetic Activity: Solar wind parameters as measured by DSCOVR at L1 were indicative of a CME Arrival at L1 at around 04/0940 UTC. The solar wind speed rose sharply from 330 km/s to 410 km/s then 440 km/s later. Density was below average initially but became briefly above average, peaking at 37 ppcc at around 04/1000 UTC. The Interplanetary Magnetic Field, Bt, was moderate but became suddenly strong between 04/1000-1200 UTC, with a peak of 27nT at 04/1039 UTC. The north-south component, Bz, remained mostly positive but became also strong between 04/1000-1200 UTC, ranging between -4nT and +22 nT. Phi angle has remained undecided, switching regularly between negative (towards the Sun) and positive (away from the Sun) through much of the period. The solar wind speed is now declining, along with a below average density and a moderate IMF, indicating the end of the magnetic cloud and a gradual return to a slow wind regime. Resulting geomagnetic activity was Quiet to Active (Kp 1-4) but with a provisitional G1 Minor Storm interval between1200-1500 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has remained at elevated levels in response to the M5.5 flare on 01 Sep. It seems to have initiated a slow decreasing trend, peaking at 6.35 pfu at 04/1030 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 increased from background to high levels during his diurnal cycle, peaking at 1310 pfu at 04/1545 UTC. The corresponding 24-hour fluence showed a sharp rising trend before levelling off later in the day. However, it remained

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well below the Active threshold, with 1.34e7 integrated pfu observed at 05/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with a slight chance of isolated X-flares. The main flare risk is currently from AR3806, AR3807 and AR3813. AR3807 is expected to rotate beyond the western limb during Day 2 (06 Sep). New or returning regions may rotate onto the disc during the period, most probably Day 3 (07 Sep).

Solar Wind / Geomagnetic Activity: The recent uptick in geomagnetic activity and solar wind speeds has been attributed to glancing effects from a large CME off the southeast limb on 01 Sep, the bulk of which was expected to pass well behind Earth's orbit. The solar wind speed is now declining, along with a below average density and a moderate IMF, indicating the end of the magnetic cloud and a gradual return to a slow wind regime. Two coronal holes are currently present on the western hemisphere, CH67/- and CH/65/+. The HSS associated with the positive coronal hole may enhance wind speeds to 450-500km/s on Day 3 (07 Sep).

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp 1-3) through this period.

Energetic Particles / Solar Radiation: High energy proton flux is above background levels, but below the S1/Minor Radiation Storm threshold. There is a chance of exceeding S1 in the coming days. High energy electron flux is expected to remain at background to moderate levels, perhaps rising late in the period following any CME effects. There is a slight chance of fluence reaching the Active threshold by the end of the period.

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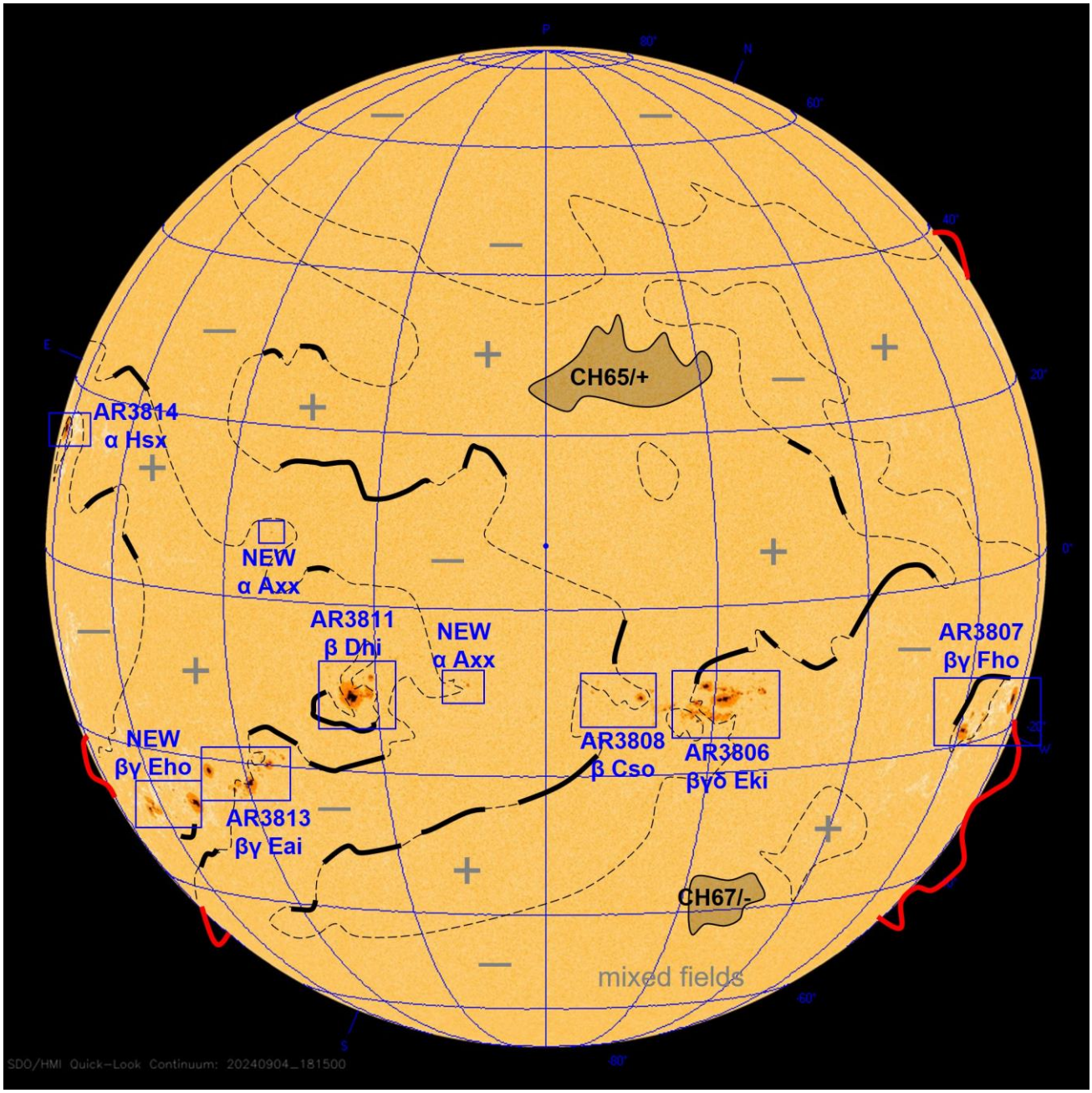
Figure 1. Solar Analysis Valid 04/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The recent uptick in geomagnetic activity and solar wind speeds has been attributed to glancing effects from a large CME off the southeast limb on 01 Sep, the bulk of which was expected to pass well behind Earth's orbit. The solar wind speed is now declining, along with a below average density and a moderate IMF, indicating the end of the magnetic cloud and a gradual return to a slow wind regime.

Two coronal holes may enhance the solar wind, CH67/- and CH65/+. The HSS associated with the negative coronal hole may is expected to connect with Earth on Day 2 (06 Sep) and the HSS associated with the positive one on Day 3 (07 Sep), which is somewhat supported by the MOSWOC persistence model (SWPM), the solar wind expected to increase roughly by 100 km/s to reach slightly elevated levels and perhaps peak close to 500 km/s. There is however a caveat. With Earth tending to connect more favourably with positive coronal holes in Autumn, the enhancement expected on Day 2 may well be minimal or simply non-existent.

On the whole, geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 1-3), perhaps peaking at Active (Kp 4) on Day 3 should a connection with the HSS from CH65/+ occurs.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

NIL.

Figure 2: Met Office Persistence Model with projected wind speeds, considered to provide reasonable guidance.

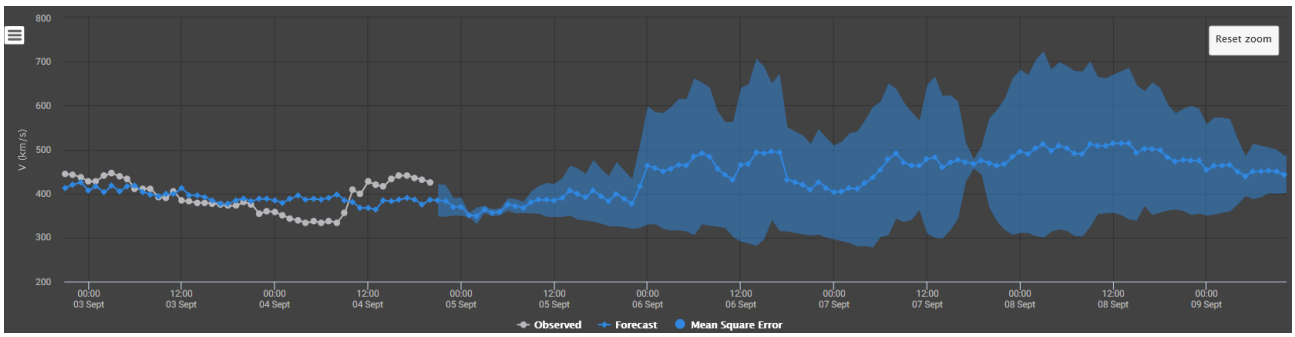

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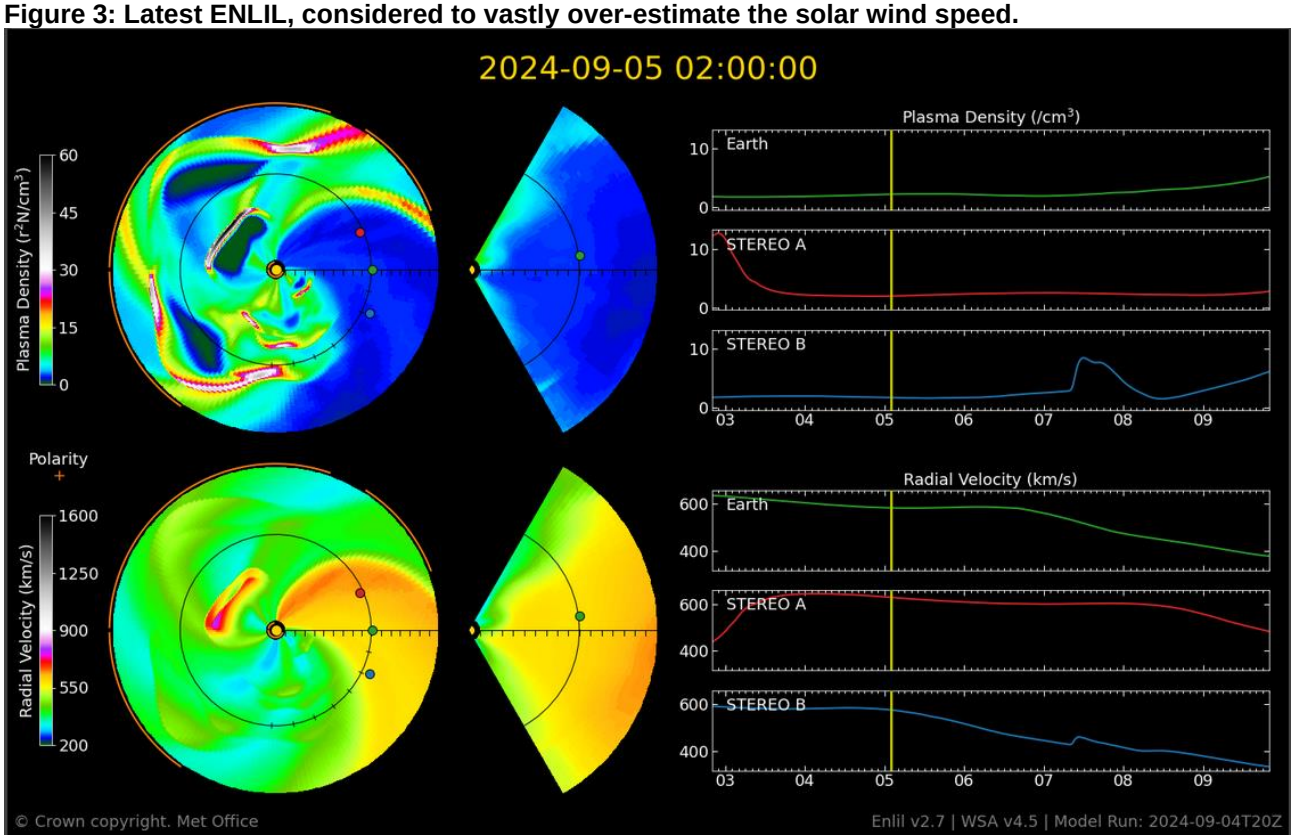
Figure 3: Latest ENLIL, considered to vastly over-estimate the solar wind speed.



Radio Blackouts - X-Ray Flares:

There are currently nine sunspot regions on the visible disc, 3 of which are unnumbered. AR3806 and AR3813 are the largest and most complex regions on the disc as AR3807 approaches the southwest limb, leading to an increasing reduction of confidence in its classification. AR3806 in the central disc has seen a proliferation of spots and appears to be increasing in complexity, with several mature penumbra forming and the presence of two delta configurations. AR3813 in the southeast has also seen a proliferation of spots and has been reclassified as Eai. The region is still showing significant looping in SDO imagery and is thought to be connected to the unnumbered region to the southeast of AR3813 contributing to the overall complexity observed on AIA-0171 and AIA-0094 imagery.

The new region from the northeast limb has been numbered as AR3814. It is currently assessed as Hsx/Alpha but this may change as it rotates fully onto the disc. All the other regions are smaller and remain generally stable or unchanged.

Activity has been somewhat deceiving over the past 24 hours, with only low-key moderate flares. Further M-class flares are expected with a chance of isolated X-class flares. Whilst AR3807 is expected to rotate off the disc early on Day 2 (06 Sep), the flare risk from this region will remain for around a further 24 hours. Brightness close to the eastern limb suggests that new or returning regions may rotate onto the disc during the forecast period, with the chance of a larger feature rotating across the eastern limb during Day 3 (07 Sep).

A flat trend for flare probabilities is largely maintained throughout, but with probabilities being lowered slightly Days 2-3 (06-07 Sep) due to a combination of departing AR3807 and reduced confidence in the behaviour of spots on the disc.

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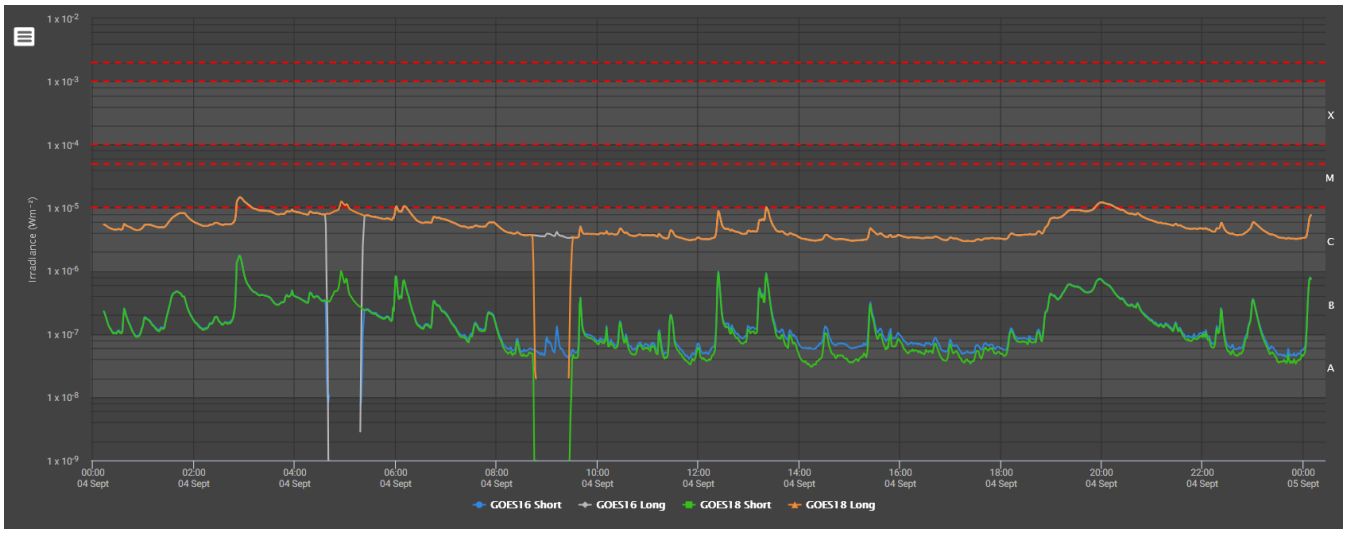
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	70	80
Very Active	R3 to R5 X Class	No	25	20	20	25

Figure 4: Latest X-Ray Flare activity, as observed at GOES-18



Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18, is above background levels in response to the large eruption and associated M5.5 flare off the southeast limb during the UTC afternoon of 01 Sep. However, the upward trend appears to be levelling off and it is considered unlikely to reach the S1/Minor Radiation Storm threshold at this time, in the absence of further notable flares.

There are several regions on the disc which could give an increase in proton flux, should they produce larger flares, including AR3807 and AR3806 in the western hemisphere. However, neither of these regions has produced flare activity of significance in recent days. Ordinarily, AR3813 would be considered a low risk of exceeding S1 from its current location in the southeast quadrant, but given it has already produced a proton response at Earth from closer to the east limb, this region will pose an increasing risk of proton flux increases as it rotates westward.

Overall, there is a chance of reaching the S1 threshold in the coming days, should there be any larger flares from any of the aforementioned regions.

Radiation Storms	Level (cm^{-2}	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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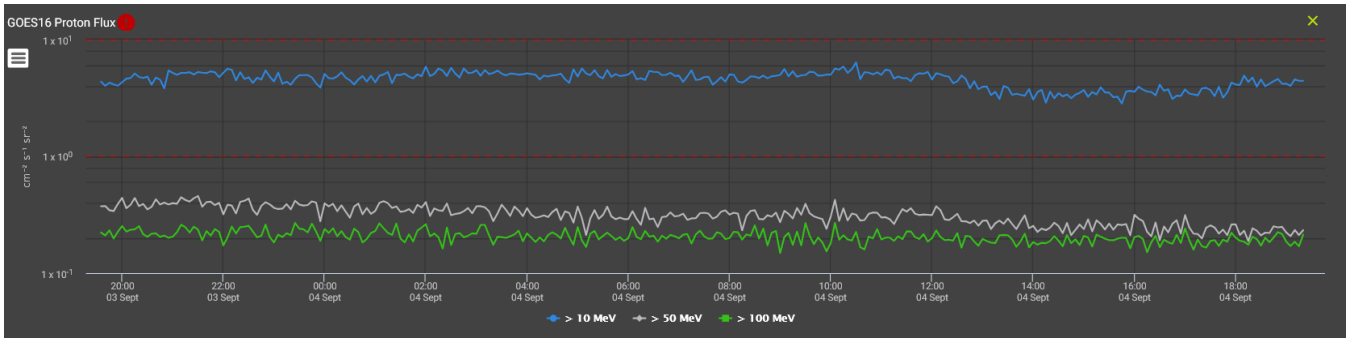
Probability (Exceedance)	$sr^{-1} s^{-1}$)	(Yes/No)	(%)	(%)	(%)	(%)
Active	**≥ S1**	No	25	25	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Latest Proton Flux, as observed at GOES-16



High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 has behaved as expected, venturing briefly into high levels during its diurnal cycle before coming back to background later on. The recent arrival of a CME will most likely disperse the electron in the short term, leading to a sharp drop in numbers. Depending on the level of the geomagnetic response, it may then drive an increase in electron flux later in the period but confidence is low and any incursion into high levels should be minor and brief.

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period, perhaps with a rising trend much later if we do see a geomagnetic response. Therefore, there is a slight chance of exceeding the Active threshold by the end of the period. MOSWOC REFM is showing the most likely forecast, below Active, but will not be taking into account any CME arrival.

GEO Electron Environment	Level ($cm^{-2} sr^{-1} day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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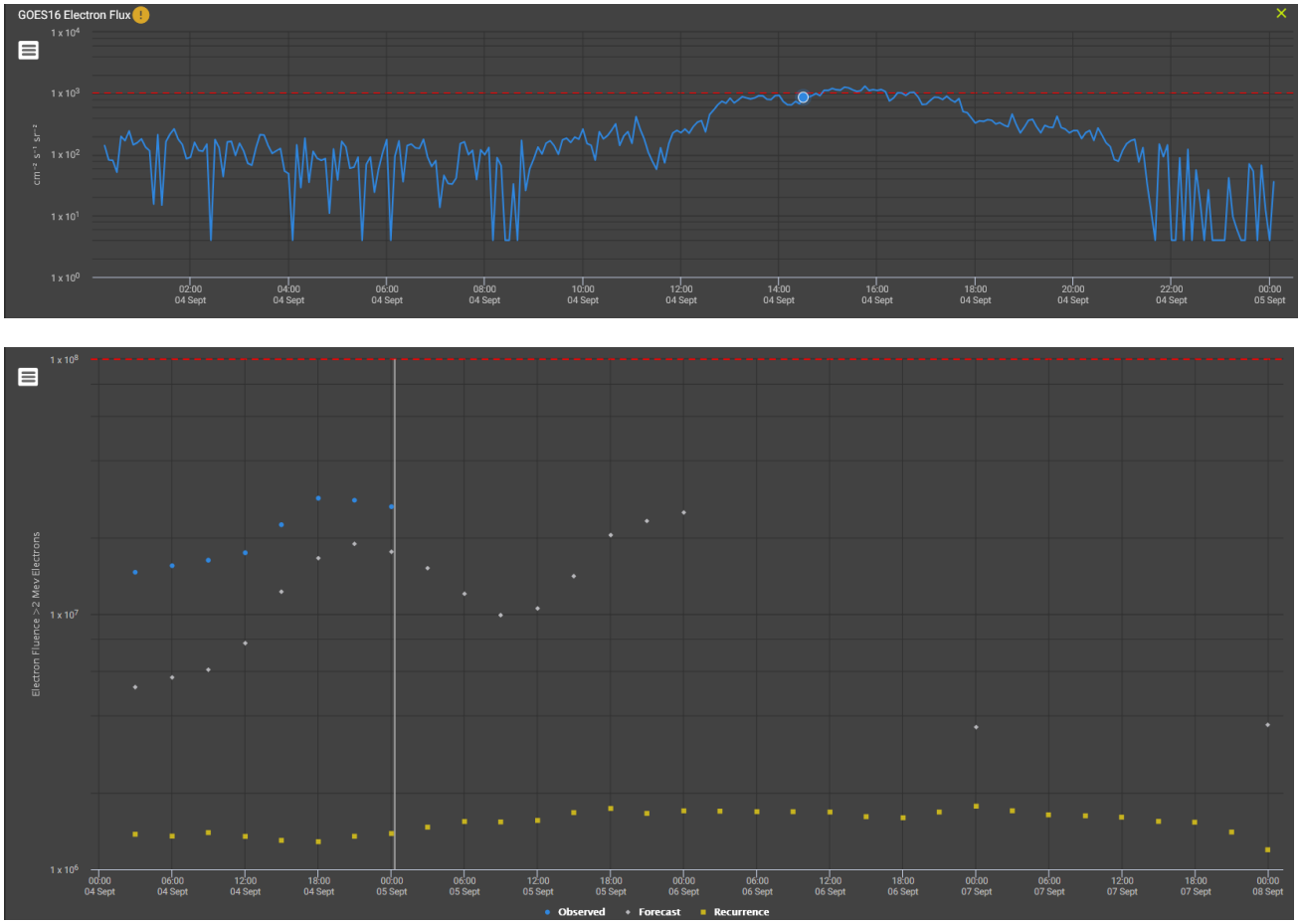
Figure 6: Latest Electron Flux, as observed at GOES-16 and REFM model output



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